GeniE User Manual
Code checking of beams
Appendix C4 – Implementation of EUROCODE

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1. IMPLEMENTATION OF EUROCODE 3

The implementation of Eurocode 3, EN 1993-1-1 is according to:

Eurocode 3: Design of steel structures – EN 1993 Part 1-1: General rules and rules for buildings, 2005

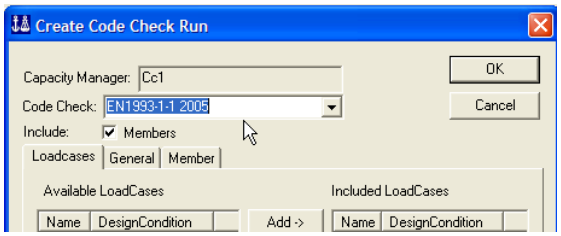
1.1 Revisions supported

The implementation is according to the revision from 2005.

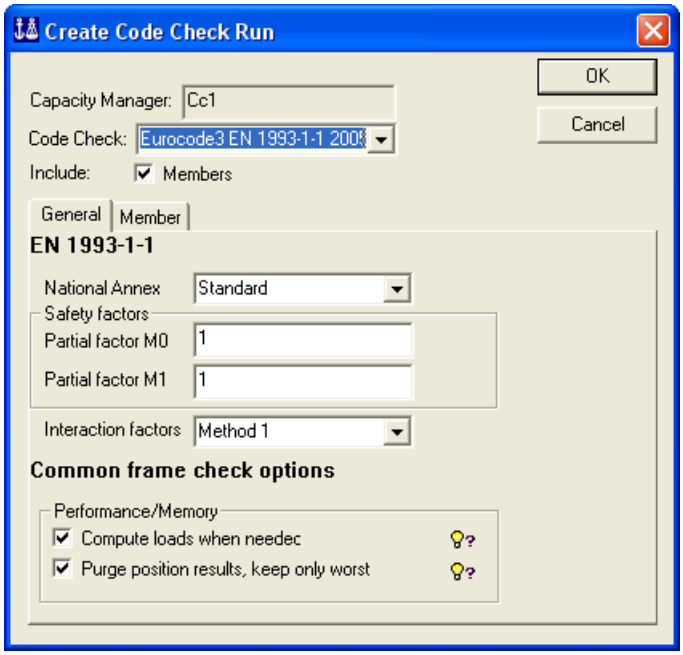
It is also an option to select the preferences according to the Norwegian National Annex, 2006

The check covers cross-section and buckling resistance check of isolated members.

Select EN-1993-1-1 from the Create Code Check Run dialog

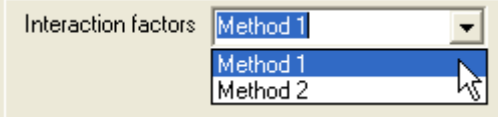


Define the global parameters:



Options:

National Annex	Select Standard to use the "neutral" version of EN 1993-1-1, or select a preferred National Annex or select from list: - Norwegian - Danish (normal or sticter control class) When selecting a National Annex the dialogs will be updated to reflect the preferred settings defined in the annex.
Safety factors	Define the partial factors γ_{M0} and γ_{M1} (will automatically update dependant of National Annex)

Interaction factors	Interaction factors for use in equations (6.61) and (6.62) may be calculated according to method1 (Annex A) or method 2 (Annex B). Select method to be used, default selection is method 1. 
Compute loads when needed	• To reduce use of database memory, you can compute temporary loads (during codecheck execution). These loads will be deleted immediately when no longer needed. • This option can affect performance on redesign, as loads must be recalculated locally every time you change member/joint settings. • With this option checked, you will always use the latest FEM loads. When unchecked, you will use the FEM loads retrieved the last time you used "Generate Code Check Loads". • Note that with option checked member loads will not be available in the report nor in object properties.
Purge position results, keep only worst	• Only worst result along a beam will be kept. • This option reduces use of database memory. • Note that with option checked results for other positions than the worst one will not be available in the report nor in object properties.

The member code check is performed according to the chapters and sections referred to in the table below:

	Design consideration	Sections covered
5	Structural analysis	**5.5** Classification of cross section 5.5.2 Classification 1) 2)
6	Ultimate limit state	**6.1** General **6.2** Resistance of cross-section 3) 6.2.2 Section properties 6.2.2.1 Gross cross-section 6.2.2.5 Effective cross-section properties of Class 4 cross-sections 6.2.3 Tension 6.2.4 Compression 6.2.5 Bending moment 6.2.6 Shear 6.2.7 Torsion 6.2.8 Bending and shear 6.2.9 Bending and axial force 6.2.9.1 Class 1 and 2 cross-sections 4) 6.2.9.2 Class 3 cross-sections 6.2.9.3 Class 4 cross-sections 6.2.10 Bending shear and axial force **6.3** Buckling resistance of members 6.3.1 Uniform members in compression

		6.3.1.1 Buckling resistance 6.3.1.2 Buckling curves 5) 6.3.1.4 Slenderness for torsional and torsional-flexural buckling 6.3.2 Uniform members in bending 6.3.2.1 Buckling resistance 6.3.2.2 Lateral torsional buckling curves – General case 6) 6.3.2.3 Lateral torsional buckling curves for rolled sections or equivalent welded sections 6.3.3. Uniform members in bending and axial compression
	Annex A	Method 1: Interaction factors k_{ij} for interaction formula in 6.3.3 Table A.1: Interaction factors Table A.2: Equivalent uniform moment factors 7)
	Annex B	Method 2: Interaction factors k_{ij} for interaction formula in 6.3.3 Table B.1: Interaction factors k_{ij} for members not susceptible to torsional deformations Table B.2: Interaction factors k_{ij} for members susceptible to torsional deformations Table B.3: Equivalent uniform moment factors

Notes to the table above:

1) The classification of flanges and web(s) are done for axial compression and bending about strong and weak axes for pure axial and bending moment actions respectively. The capacities for a cross section with the largest part classification in class 4 is done according to the classification corresponding to the load action in question. (See section 6.2.9.3 item (2).)
2) Pipe sections in class 4 are not supported. Class 3 is used.

   Flat bar sections are treated as class 3 only in automatic classification. Class 4 is not supported. If manually set to class 4, class 3 will be used.

   T shaped sections (degenerated I/H) are treated as class 3 only.
3) General section is treated similar to the flat bar section but is limited to class 3 behaviour. The following values are used in the calculations:

   height = 2*Iy / Wy

   width = 2*Iz / Wz
4) For pipe sections $M_{N,Rd} = M_{pl,Rd}(1 – (N_{ed}/N_{pl,Rd}))$ is used.

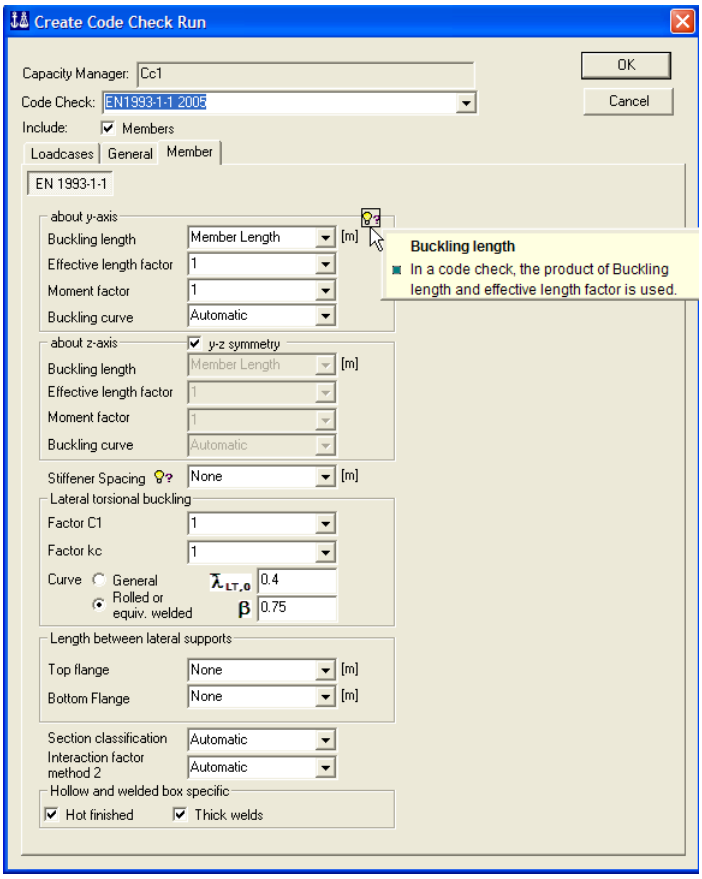
   For channel sections equations (6.36) – (6.38) are used.
5) Ref. 6.3.1.2 (4): The paragraph in the standard says “may be”. In this implementation buckling effects are always checked.

6) Ref. 6.3.2.2 (4): The paragraph in the standard says “may be”. In this implementation lateral torsional buckling effects are always checked.
7) The maximum member displacement to be used in one of the formulas is a simplified calculation based on the bending moment distribution and stiffness.

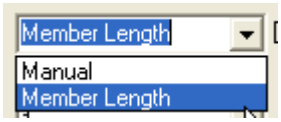
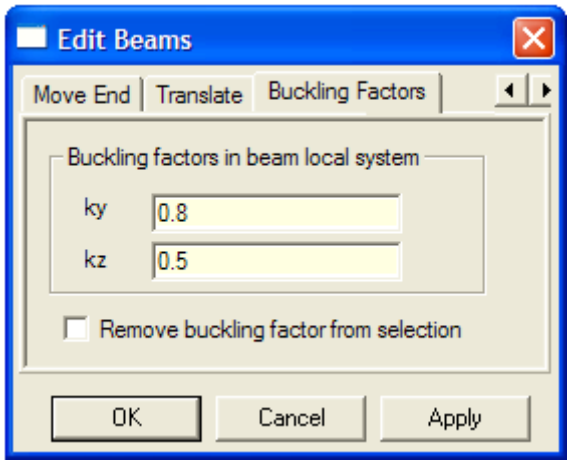
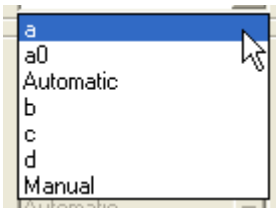
Also note the following:

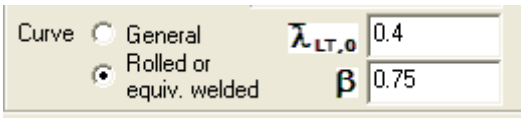
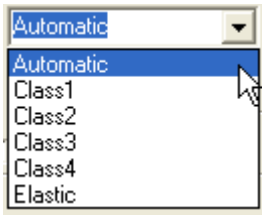
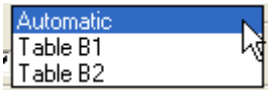
- Un-symmetric I sections are in current implementation treated as single symmetric.
- Code check of L sections is based on principal axes (u and v axes).
- All cross sections are as default set to fabrication status “Unknown”. Unkown is in the code check treated as Built-up (Welded). Note that sections read from the section libraries are also set to status “Unknown”.

Definition of member specific parameters:



Options:

Buckling length	Member Length = use the geometric length of the member (capacity model). Manual = specify the length to be used 
Effective length factor	Specify the factor to be used or select From Structure = the value assigned to the geometric beam concept is used, ref. Edit Beams  The From Structure alternative is only accepted in cases with one-to-one mapping between modelled beam and member. (Else factor of 1.0 will be used.)
Moment factor	Specify the value to be used or select rule based calculation according to the standard
Buckling curve	Specify the imperfection factor α to be used or select between the options: Curves a, a0, b, c. d or Automatic selection of curve according to Table 6.2 “Selection of buckling curve for cross-section 
Stiffener spacing	Use “None” for no web stiffeners or specify the length between stiffeners.

Lateral torsional buckling	Specify the factors C1 and kc for lateral torsional buckling or select rule based calculation according to the standard. The alternative for calculating χ_{LT} (based on buckling curve) for lateral torsional buckling must also be selected.  Note that automatic calculation of C1 only supports "simple linear moment distribution"
Length between lateral supports	Specify the length between lateral supports of top and bottom flange.
Section classification	Select how to handle the cross-section classification; - manually give the class - automatic classification - elastic = automatic classification, but limited to 3 or 4 
Interaction factor method 2	Selection regarding alternatives for interaction factors, Annex B (method 2) Table B1. vs. Table B.2. 
Hollow and welded box specific	Select hot finished (vs. cold formed) and thick welds (vs. generally) with respect to automatic definition of buckling curves, see Table 6.2.

1.2 Nomenclature – EUROCODE 3

1.2.1 Member check – EUROCODE 3

The print of all available results inclusive intermediate data from the member check will report the following data.

Member	Capacity model name (name of Beam(s) or part of beam representing the member)
Loadcase	Name of load case/combination under consideration
Position	Relative position along member longitudinal axis (start = 0, end = 1)
Status	Status regarding outcome of code check (OK or Failed)
UfTot	Value of governing usage factor
Formula	Reference to formula/check type causing the governing usage factor
SubCheck	Which check causes this result, here Eurocode EN 1993-1-1 member check
GeomCheck	Status regarding any violation of geometric limitations
ufEuler	Usage factor equal ratio for axial compression / Euler capacity
ufAxial	Usage factor equal ratio for axial load / design resistance for axial loading
ufTorsion	Usage factor due to torsion
ufShearz	Usage factor due to shear in local z direction
ufSheary	Usage factor due to shear in local y direction
ufXSection	Cross section usage factor according to section 6.2.9 and 6.2.10
uf646	Usage factor according to equation (6.46)
uf655	Usage factor according to equation (6.55)
uf661	Usage factor according to equation (6.61)
uf661ax	Axial contribution to usage factor according to equation (6.61)
uf661mo	Moment contribution to usage factor according to equation (6.61)
uf661my	Moment contribution (about local y axis) to usage factor according to equation (6.61)
uf661mz	Moment contribution (about local z axis) to usage factor according to equation (6.61)
uf662	Usage factor according to equation (6.62)
uf662ax	Axial contribution to usage factor according to equation (6.62)
uf662mo	Moment contribution to usage factor according to equation (6.62)
uf662my	Moment contribution (about local y axis) to usage factor according to equation (6.62)
uf662mz	Moment contribution (about local z axis) to usage factor according to equation (6.62)
sldComp	slenderness ratio (beam in compression)
relpos	Relative position along member longitudinal axis (start = 0, end = 1)
fy	Yield strength
E	Young's modulus of elasticity
gammaM0	Partial factor M0
gammaM1	Partial factor M1
NEd	Design value of axial force (positive when tension)

MyEd	Design value of moment about local y axis (strong axis)
MzEd	Design value of moment about local z axis (weak axis)
TEd	Design value of torsional moment
VyEd	Design value of shear force in local y direction
VzEd	Design value of shear force in local z direction
KLy	System length for buckling about local y axis
KLz	System length for buckling about local z axis
L	Length of member (length of the capacity model)
Ncry	Elastic flexural buckling force about local y axis
Ncrz	Elastic flexural buckling force about local z axis
NtRd	Design value of the resistance to tension force
classF	Cross section classification, flange
classW	Cross section classification, web
NcRd	Design resistance to nornal force for uniform compression
MycRd	Design resistance for bending about local y axis
MzcRd	Design resistance for bending about local z axis
alphay	The imperfection factor according to buckling curve for buckling about local y axis
alphaz	The imperfection factor according to buckling curve for buckling about local z axis
chiy	Reduction factor for buckling resistance about local y axis
chiz	Reduction factor for buckling resistance about local z axis
NbRd	Design buckling resistance of a compression member
C1	Modification factor for moment distribution
Mcr	Elastic critical moment for lateral-torsional buckling
chiLT	Reduction factor for lateral-torsional buckling
MbRd	Design buckling resistance moment
Cmy	Equivalent uniform moment factor, bending about local y axis
Cmz	Equivalent uniform moment factor, bending about local z axis
CmLT	Equivalent uniform moment factor, lateral-torsional bending
kyy	Interaction factor kyy calculated based on method 1 or method 2
kyz	Interaction factor kyz calculated based on method 1 or method 2
kzy	Interaction factor kzy calculated based on method 1 or method 2
kzz	Interaction factor kzz calculated based on method 1 or method 2

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